JPL NO. 9950 – 1078

SHUTTLE IMAGING RADAR-B (SIR-B) DATA ANALYSIS FOR IDENTIFYING RAINFALL EVENT OCCURRENCE AND INTENSITY

FINAL REPORT

Prepared for:

California Institute of Technology
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91109

JPL Contract No. 956909

March 1985

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This work was performed for the Jet Propulsion Laboratory California Institute of Technology, sponsored by the National Aeronautics and Space Administration.

ABSTRACT

The purpose of this project is to evaluate the utility of SIR-B data for the detection and measurement of rainfall events, and to develop applications of SIR-B data to the improvement of existing rainfall models.

During the SIR-B mission, EarthSat monitored rainfall events occurring within the conterminous United States, using our in-house meteorological facility. GOES scenes were archived in hard copy form (black-and-white photographic prints) showing rainfall activity within the conterminous U.S. during the SIR-B mission.

Swaths of the actual SIR-B data takes acquired during the mission were plotted onto the GOES satellite scenes most closely representing the time of the Shuttle overpass. This allowed EarthSat to select or reject SIR-B data takes for subsequent analysis in other tasks. A request for suitable SIR-B data takes was submitted to the JPL Technical Manager along with photo copies of the GOES prints.

JPL provided EarthSat with available SIR-B imagery in paper print form representing the appropriate requested data takes. Specific digital SIR-B data tapes for selected segments of each SIR-B swath are to be sent to EarthSat by JPL shortly.

EarthSat has identified and requested from the appropriate sources the collateral data required for site characterization during subsequent SIR-B contracts with JPL.

1.0 PURPOSE AND SCOPE

The purpose of this project is to evaluate the utility of SIR-B data for the detection and measurement of rainfall events, and to develop applications of SIR-B data to the improvement of existing rainfall models. The objectives of the experiment are:

i. To determine whether known rainfall events can be consistently detected in orbital radar imagery;

ii. To classify the independent variables of the surface environments (e.g., land use, land cover, climate, terrain, etc.) where rainfall is detected and correlate observed SIR-B signal returns with these variables;

iii. To perform a statistical analysis of the signal returns where rainfall has been detected and evaluate the extent to which rainfall intensity can be measured and contoured;

iv. To develop digital methods of SIR-B data enhancement for the purpose of rainfall detection which may be used to increase the resolution and accuracy of existing rainfall models.

In partial fulfillment of these objectives, Earth Satellite Corporation (EarthSat) has completed the following tasks as part of JPL Contract No. 956909. Additional tasks are to be completed under subsequent contracts with JPL in order to meet the total project objectives:

- Task 1 - Screen SIR-B Data and Conduct Preliminary Rainfall Analysis
- Task 2 - Review SIR-B Browse File to Identify Specific Rainfall Locations
- Task 3 - Locate Collateral Data for Rainfall Event and Site Characterization

2.0 METHODS AND APPROACH

The above listed tasks were completed using the methods described below.

TASK 1 - Screen SIR-B Data and Conduct Preliminary Rainfall Analysis

During the SIR-B mission, EarthSat monitored rainfall events occurring within the conterminous United States. We accomplished this at our in-house meteorological facility which has a UPI Unifax II GOES Satellite Receiver. This receives cloud photographs every half-hour covering the entire world. North America data is acquired from the Wallops Island, Virginia receiving station, via NESS.

EarthSat archived all GOES scenes in hard copy form (a black-and-white photographic print) showing rainfall activity within the conterminous United States during the SIR-B mission.

Upon receipt from JPL of information on actual data takes acquired by the SIR-B, EarthSat plotted each radar swath onto the GOES images most closely representing the time of the Shuttle overpass. Table 1 compares time of SIR-B radar data acquisition for a given overpass with the time of GOES image acquisition. Plotting of the SIR-B swaths onto the GOES images enabled us to match the actual ground swath covered by the SIR-B with specific rainfall events occurring along the swath. By using this procedure we selected or rejected SIR-B data takes for subsequent analysis in other tasks.

Table 2 summarizes our SIR-B data selection. EarthSat meteorologists analyzed both the GOES images and associated data from existing meteorological ground stations in order to identify rainfall activity occurring during the SIR-B mission. A preliminary rainfall search was conducted during the SIR-B mission using: 1) infrared GOES images within 15 minutes of data take time; 2) visible GOES images, if available, within 30 minutes of data take time; 3) 24 hour station rainfall; and 4) 24 hour CROPCAST areal average rainfall in 48 x 48 kilometer cells. A senior EarthSat meteorologist specializing in satellite rainfall analysis, segmented each SIR-B swath into rain/no rain segments using GOES image cloud brightness and texture techniques. The image analysis was then compared to the ground station rainfall data, and CROPCAST rainfall, and adjusted accordingly, if necessary.

EarthSat submitted an interim technical report to JPL in December, 1984 identifying our SIR-B data take selection procedures and results.

TASK 2 - Review SIR-B Browse File to Identify Specific Rainfall Locations

In our December, 1984 interim technical report to JPL, EarthSat requested information regarding the existence and use of a SIR-B browse facility to identify SIR-B data take segments covering specific rainfall locations. Subsequent phone discussions with the JPL Technical Manager indicated that an EarthSat trip to JPL to view the SIR-B data would most likely not be the most efficient way to proceed. EarthSat and the JPL Technical Manager agreed instead that JPL would mail to EarthSat all available SIR-B photographic prints for the data takes identified in Table 2 of this report. EarthSat would then select the appropriate data take segments and request the digital SIR-B tapes for those segments only. During a subsequent visit by the JPL Technical Manager to EarthSat's facility on February 28, 1985, EarthSat provided to the Technical Manager photo copies of the GOES prints. These were to be used by JPL to identify SIR-B data take segments required by EarthSat for the project.

Table 1: Comparison of Acquisition Times for SIR-B and GOES Data

Data Take	Date		GMT SIR-B	GOES
38.1	70CT84	Start	1920 hrs.	1930 hrs.
		Finish	1928	
49.2	80CT84	Start	1122	1130
		Finish	1125	
54.1	80CT84	Start	1903	1900
		Finish	1911	
65.2	90CT84	Start	1104	1100
		Finish	1114	
70.1	90CT84	Start	1850	1900
		Finish	1853	
81.2	100CT84	Start	1047	1100
		Finish	1051	
86.1	100CT84	Start	1830	1830
		Finish	1847	
97.2	110CT84	Start	1032	1030
		Finish	1033	

Table 2: Summary of SIR-B Data Selection

Data Take	Acceptable ?	Comments
37.2	No	Clear sky, no companion data take with rain.
38.1	Yes	Light to moderate rain falling in Dakotas, Illinois, and Kentucky during data take. Companion to 54.1, 70.1, and 86.1.
49.2	Yes	No rain in Illinois can be used in comparison with companion data take 97.2 that has rain.
53.2	No	Cloudy, but no rain. No companion data takes with rain.
54.1	Yes	Is a good companion data take with 38.1, 70.1, and 86.1. Light rain in Iowa, clear in Illinois.
64.2	No	Clear sky, no companion data take with rain.
65.2	Yes	Data take passes through edge of thunderstorm cluster in Oklahoma, plus can be used as background case in Iowa.
70.1	Yes	Is a good companion data take with 38.1, 54.1, and 86.1. Also hits thunderstorm in southeast Tennessee.
		Clear sky, no companion data take with rain.
81.2	Yes	Moderate to heavy rain in Arkansas. Best data take for viewing heavy rainfall rate.
85.2	No	Cloudy with no rain, no companion data take with rain.
86.1	Yes	Light to moderate rain falling in the Dakotas and Iowa. Can be used as companion to 38.1, 54.1, and 70.1.

Table 2 (continued)

Data Take	Acceptable ?	Comments
96.2	No	Clear sky, no companion data take with rain.
97.2	Yes	Light rain in Illinois, good companion to 49.2.
118.2	No	Clear sky, no companion data take with rain.

TASK 3 - Locate Collateral Data for Rainfall Event and Site Characterization

Collateral data for describing the rainfall event and terrain characteristics for each rainfall site include:

- Landsat MSS and TM imagery
- Weather satellite imagery
- Topographic quadrangles
- On-ground published meteorological data
- Soil and geology maps
- Station rainfall data derived from EarthSat's CROPCAST rainfall data base

Landsat MSS and TM Imagery

EarthSat requested from the JPL Technical Manager on March 13, 1985 cloud free Landsat TM data for the following paths/rows.

Path/Row
20/35
21/35
23/33
24/32
24/35
29/29
29/35
32/27

MSS data were not requested since TM was more readily available from JPL and contains the necessary spectral and spatial resolution to perform the land use/land cover assessment of each rainfall site.

Weather Satellite Imagery

GOES weather satellite imagery as described in Section 2.0, Task 1 of this report has been acquired for this project. Digital GOES data, which will provide higher resolution information on rainfall occurring during the SIR-B mission, has been ordered from the Satellite Data Services Division of NOAA.

Topographic Quadrangles

Approximately sixty-one (61) USGS 1:250,000 scale topographic maps illustrate the topography for the project area. EarthSat believes

that 1:250,000 is an appropriate scale for evaluating topographic conditions in the project area, and that larger scale maps are not required. EarthSat has in-house all 1:250,000 scale topographic quadrangles required for the project.

On-Ground Published Meteorological Data

EarthSat maintains in-house all required ground station meteorological data for this project.

Soil and Geology Maps

Medium scale soil and geology maps have been ordered for the project area. Geology maps to be used are state maps at 1:500,000 or 1:1,000,000 scales. Soil maps vary in scale depending on availability. Additional, larger scale soil and geology maps may be obtained during subsequent SIR-B contracts once data analysis commences, and a need is identified for more detailed site analysis.

Station Rainfall Data Derived From EarthSat's CROPCAST Rainfall Data Base

Ground station precipitation and temperature data are available from EarthSat's in-house files.

3.0 MAJOR FINDINGS

During the SIB-B mission a number of rainfall events occurred in the conterminous United States. SIR-B data were acquired over these rainfall areas prior to, during, and after the rainfall activity. Comparative SIR-B data are, therefore, available so that this project may proceed as originally planned.

All required SIR-B data takes for this investigation have been identified and ordered from JPL. Also, collateral data required for subsequent rainfall event and site characterization, are available and have been ordered from the appropriate sources.

4.0 CONCLUSIONS

All tasks under JPL Contract No. 956909 have been completed successfully. Analysis of the SIR-B data for evaluating rainfall events will commence upon award by JPL to EarthSat of a follow-on contract, and receipt from JPL of the SIR-B data.

5.0 NEW TECHNOLOGY

No new technology items are identified in this report.